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# In the Search for a Modern Educational Sky Simulator at the Beginning of the Digital Age

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**Abstract**

The Digital Age has brought the most significant changes in the fascinating world of planetarium. Since 1998, in the whole world, several firms and hundreds of specialists are in a competition to develop theoretical and innovative technical approaches to produce tools that facilitate Space understanding through multimedia virtual simulation.

The digital multimedia sky simulator, meaning a specialized software capable to „navigate" through the stars projected on a screen, is the main new Digital Age change in planetarium world. The multimedia content through CGIs, several projectors simultaneous image, 3D and immersive digital projection are run together by one set of software commands designed on specific methodology. Some kindergarten kids or astronauts enjoy to learn and to visualize the universe using this new educational tool. This paper is meant to help select the modern up-to-date sky simulator you need. One can find a digital multimedia sky simulator as free or expensive, as open source or as a licence based, strategic or almost classified software, able today to deliver more that natural sciences content.


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## 1.Motivation

The dream of those dealing with the development of digital technologies for viewing and projection is to have an image with a resolution on the acceptance of reality with the help of the human eye and with human-eye - like snapshot visual field, so all the receptors of the retina to be used to receive the Visual information. The first visualization technology that is beginning to turn this dream into reality is the Digital Sky Simulator for Planetarium, using its multimedia *fulldome* video projections, that is, a projection on the whole surface of a half-sphere screen, of a domed screen. This is a multimedia wonder tool able to enhance and to promote all training jobs.

The f*ulldome* name could be a generic name, for general use, common to this type of projection, however, for reasons of diversification and differentiation in the commercial environment of digital projection systems,

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*fulldome* remained only as a general name of digital planetarium projection, experienced since 1983 (https://www.es.com/Support/DigistarI.html). Symbiotic, since 1995, one can add the sound as information and equipment to the planetarium, from gadgets to the serious, professional installations and purposefulness in the world of scientific research, thus the planetarium becomes a multimedia systems (http://dev.twinisles.com/research/bsvr.htm#vd).

The technologies for entertainment and public promotion of science are designed to 'deliver' memorable experiences accessible to all types of audiences. Already, some of the historical improvements to the cinematographic technology to serve that purpose were centred on designing a bigger, a brighter and with more information (higher video resolution) image. The higher brightness and resolution bring more realism to the image, while increasing the size of the image means a greater visual impact and an increase in attendance felling, in the impression of the level of immersive, at the subjective and emotional plane.

The latest technical developments in the field of cinematographic technologies are related to digital cinema, computer-based, using the digital video projectors, advanced graphics tools and virtual/animated image projected, which tend to replace the projection technologies based on the film, fully experienced and used in the last hundred years. *Virtuarium* ... a pack of hybrid technologies, digital and analog ones, to project images on large screens and semi-spherical screens is presented as a world premiere at Osaka in 1996 and was, by design, intended mainly to astronomy education -http://www.goto.co.jp/english/product/v2_virtuarium.html.

The planetariums have never been just a fashion. They were not just a form of transient media stated by critiques stirrings in Hamburg in the year of 1929, but it is still from its draft, a mature institution, originally just a 'copy' of the celestial vaults mediated by technology. Today, totaling over three thousand fixed functional planetarium halls worldwide (Petersen, 2005, 102), represent the spaces where the simulated sky is increasingly closer to the real one when, in metropolitan areas, light pollution makes the sky opaque.

Returning to the sky, to the most important visual show of humanity, dark adaptation is not longer required to enter the planetarium for most of the visitors, because the of the special designed optical fibre star projectors. The specify aesthetic adaptation to illumination was replaced with adaptation to the elements of the projection. In a classic planetarium, you had only to wait until your eyes adjust to the light of twilight and even in the dark because they knew that it will be listed/projected just the constellations and main celestial bodies. The dramatic effect achieved during the human eye adaptation is immediately rewarded with the association between communication environments of fractions of a second which relive every event surprisingly relived during the so many film sequences to be found in other genres of documentary and artistic films. Recently, the planetariums have turned the arid astronomical conference halls in hybrid and multimedia arenas and have surpassed the old methods of presenting information about astronomy. The visual aesthetics and communication history can be described and rewritten as a history of user interfaces that deliver information with increasingly more realism to more receptors presented physically or virtually, even, online (Biocca & Levy, 1995, 15-31). The benefits for paedagogy, for training methods from this technology are multiple, starting from immersive visuals, static and dynamic ones, to illustrate and sustain teaching&training concepts and workflows, up to interactive and intuitive „treasure-quest" type lessons useful for multidisciplinary and interdisciplinary contents, mainly those based on natural sciences and introductions to other sciences.

From print to radio and then in the video, the technological improvements made to the media of communication was done by a greater similarity with the human capacity to communicate and to receive especially the world around him. In the case of Visual technologies, the similarity consists in 'demand for screens that are as close to their range and height to the whole of the human field of vision,' the only thing constant in the equation astronomy educational & documentary film, in particular, film for the Planetarium and its audience (Biocca & Delaney, 1995, 57-142). As trajectories or as images, modern astronomical databases can be imported into digital planetarium equipment and the latest discoveries can be explored through the simulation of investigated scenarios of celestial mechanics. They can carry mental and virtually the audiences on the edge of the visible universe, they can simulate hypothetical astronomical voyages and travel back and forth into the future, in time and space. The planetarium is today a three dimensional even interactive visual map of the known universe made available to the grand public. By animating the depth-of-field, the public can find out something that can't be explained otherwise; man puts himself in place of the Cosmos and of the Earth and becomes inquiring on the relationship between humanity and the universe. Right from the first commercial uses in planetariums, the Digital Sky Simulator has

emerged as en experiment and then expanded as a proprietary technology applied in the multimedia entertainment world, labeling this segment of the multimedia market, thanks to the more than 90 million visitors registered Planetarium in late 2003 (LNP, 2002, VI).

Because we plan that the visual experiences and, especially, the *fulldome* immersive to 'fill' the retina, we should expect that these images will receive a full feedback from peoples olfactory, vestibular system, a system inexperienced so far in this virtual environments and not studied enough so that one can already tell the border between the misdirection, manipulation, even cyber-illnesses and diseases and the mediated digital visual knowledge beneficial and refreshing for humans (Lappe, 1999, 328-336).

The *fulldome-Imax* productions and image aesthetics is already studied by physiologists and psychologists, even if the critics, producers of multimedia film and teachers have not reached to their conclusions on this new applied aesthetics. Visually, we communicate already in a language that was only a dream a century ago. Moreover, it seems that the film frame is no longer the molecule of the visual communication. We preserve its above mentioned role as a benevolent aesthetic galantery extended from the power of *fulldome*/immersive new vectors of communication (i.e. capturing the attention due to a projected volumes, definition or visual ocultation, to guide emotions and even the impression of ' live ' action, of participation 'in real time' in the 'how the film ends' mental and visual mathematics (http://www.cs.princeton.edu/~benshedd/ExplodingtheFrame.htm). Some of us already are achieving this new aesthetics of visual communication, shaped in the early years of their lifes.

The life of the *fulldome* systems, especially of the immersive ones, their role in the contemporary paradigms of communication depends on our ability to creatively rethink and rewrite this new image aesthetics, in theory, not based on film frames *ratio* and even without physical limitation in our field of vision (Damian, 2003, 13). A Science Communicator, a pedagogue, surely, will examine some of these aspects of cinematographic aesthetics specific to the Educational Sky Simulator and this is driving the production of a multimedia *fulldome* products correctly in order to find the best fit for an educational context these professionals wish to build towards achieving the objectives of their professional activities.

## 2. The Educational and *New Media* Context.

The contemporary educational context cannot be defined and understood without explaining what is *new media* and, in this regard, Lev Manovich, first of all, list the categories of products and environments often discussed and related to this topic in the popular press: 'the Internet, web sites, virtual worlds (interactive 3D environments, computer-generated), virtual reality (VR), multimedia, computer games, interactive installations, animation, computer, video, digital cinema, digital and human-computer interfaces. '(Manovich, 2001, 8-9). According to Manovich, the ordinary man, in order to comprehend what is *new media* and what are its effects on society, he must observe the effects of digital culture as a whole. Manovich contends that, without a doubt, we are in the midst of a 'new media' revolution, and witnesses initial effects 'on ... 'through computerisation of culture and all forms of production, distribution and communication of culture ' (Manovich 2001, 10). It is a revolution through the development of 'technical' with implications beyond the ones left by the introduction of the printing press in the 14th Century and of the photography in the 19th Century.

All of these new forms of documenting take place not only through the use of computational and communications capabilities of the Internet via software and specific applications, but, above all, thanks to the prevailing use of the Internet as one of the major means of daily communication. Today, the maker of documentary films is a contemporary version of a storyteller. In the modern past, rather, the storyteller wrote them down, listening to speech of many nameless storytellers. At the beginning of the 20th century, documentary filmmakers have 'written' these stories with their audio/visual appliances in an audio visual language. (Benjamin, 1969, 83).

The digital age has intensified this radical cultural act. These numerous and more impresive acts over the way of seeing and making movies are the basis of the development of digital image technology, which shares many of the same resources and positions, identifiable items up in the production of the cartoons and in video games. The course of convergence media is so forced also by the rapid growth of the market in the area of video games and in the 'horizontal integration' of media industry generated by the computerized imaging (Manovich, 2001, 69). The

Digital technology has become incorporated into planetariums and the use of these digital *fulldome* environments have been diversified to include non-astronomical applications based on entertainment and on other educational levels. The surface projection of the spherical digital fulldome type can be used as a canvas for your computer in real time applications or for animations, live images, rendered ones or basically any other Visual projection together with its digital surround sound.

The potential use of modern technology as educational tool is a current topic. The use of immersive virtual environments is a particularly interesting case because of formal and informal results obtained. A specific example of this exciting technology is offered by digital *fulldome* projections. The field is increasingly to the attention of researchers (Lantz, 2006, 1-3). Thus, digital *fulldome* environments have applications in education and entertainment, and in a wide range of other disciplines. The Digital *fulldome* projection is a medium of information facilitated by an immersive digital video projection, which is the screen a dome (5-30 m diameter). The projections of the *fulldome* medium complexity are usually the basis of derived technology called digital planetariums (Yu, 2005, 6-10). Briefly and generally, the planetariums, as digital multimedia simulation installations are intended for the communication of information that meet educational astronomy to the public missions of a Museum or to a Center for science promotion. In Europe, the planetariums placed in the educational institutions, along with those hosted in scientific centers are the natural ducts through which the flow of information related to astronomy and Astronautics reach to the general public (Ros, 2009, 26).

The Fulldome projection is a result of the information and communication technology (ICT) applied as new media especially in the educational and entertainment institutions (see also the *Omnimax* and *Imax*). It is often found as a way to open museums to the digital world within the real world and is a recurring topic of discussion about up-to-date information in the museums and their visitors media experiences. After the Web 2.0 and social media *boom*, with nearly overwhelming access to digital information via portable devices, it appears that we are approaching a new cycle: the one of the immersive projection and environments to achive knowledge.(Creative Research, 2002, *passim.*).

## 3. The Digital Sky Simulator – Searching for a Identikit.

Invented in stormy interwar period of the 20th Century, the institution of planetarium has presented, in the first place, the sky through an unusual Convention relating to celestial bodies and to the distances between them and it superseded culturally and aesthetic the distances sternly described and increasingly more present in the humans mind often due to the modern invasion of the pressured density cities. The Planetarium show at first only the Sky constellations and the solar system, beyond a painted horizon, or accepted as a depicted celestial mechanical application, it was trying to suggest stereoscopic vision through the difference in light intensity between celestial objects, without notable success, especially in the case of opto-mechanical planetariums under 10 metres in diameter. The philosopher Edmund Husserl called this phenomenon 'the homogenization of astronomical distances' (Faber, 1940, 320). So, the first planetariums has to be big. The Modern digital Planetariums and, in particular, those that have hybrid syncronised opto-mechanical systems and 3D projection, ensures and opens wide the gate of visual illusion of simulated universe projected on the same dome, sometimes (Fairall, 2005, 119). Now, the planetarium is even mobile or easy to install in every major hall, even the screen became foldable and inflatable.

Reviewing constructors sites, we will try to sketch an identikit of Digital Sky Simulator, noting one at a time, the role of visual components of the simulation (horizon/projection room, realism of projection, the depth of field of vision, the projection system (opto-mechanical and digital) and the role of contact components with the public in a planetarium (the planetarium seats, sound ambient and atmospheric comfort). As sound and atmosphere, the planetarium must be similar to a movie theater, with an explanation that the seats should provide support to the head of spectators. The projection horizon even must be parallel with the floor of the Hall to create the sensation of real sky sight. The rest of the visual components are the product of the Sky Simulator equipment either analog or digital, as technology. In table no. 1, we'll focus on generic features of the Sky Simulator, especially digital variants. This synthesis is subject to improvement from the beginning and is part of a modern technological race.

Table no.1. Generic Planetarium Kits Activities and Main Software and Hardware Characteristics

| **Planeta-rium type (1,2,3,4)** | **Planetarium Equipment Short Description & Activities** | **Generic Characteristics 1) Hardware 2) Software** | **Coments** |
|---|---|---|---|
| *Type 1 Opto-mecanic* | Starry Night Optic Simulator<br><br>Basic Astronomy and Night Orientation Activities | 1.GUI to drive the optic-electronic-mechanical harware<br>2. No Digital Sky Simulator or fulldome<br>No multimedia<br>No interchangeble content | *Still the closest projection to Real Sky Image and Motions*<br>Star field dynamic<br>Point-like stars<br>Realism of brightness<br><br>*Proffesional Warranty* |
| *Type 2*<br><br>*Digital OSS&H* | -OSS Digital Sky Image Projection and Simulator<br>-OSS flat, truncated and fulldome films,<br>-up to 2K Video resolution<br>-2D/3D Slide-foto-videoplayer<br>-Natural Sciencies and Night Orientation Activities | 1Laptop OSS GUI to drive the DLP/LCoS digital projection harware<br>2. OSS Digital Sky Simulator or fulldome<br>General Use and Home Products items in Kit and all OS. | *-Fit mainly for mobile kits*<br>-Basic Educational Tool<br>-Multimedia<br>-Interchangeable content<br>-Affordable Price<br>*-Open Source Software & Hardware = OSS&H* |
| *Type 3*<br><br>*Digital*<br><br>*Licenced SS&H* | -Digital Mapped Sky Projection Fulldome films,<br>-up to 8K Video resolution<br>-2D/3D Slide-foto-videoplayer<br>-Digital Sky&Celestial Bodies Space and Time Simulator Simulator and fulldome Producer<br>-Natural Sciencies and Space Navigation, Scientific and Multimedia Entertainment Activities | 1. Proffesional or Prosummer Quality and Waranty Digital Computing and Video Hard-ware (High Industry Stands).<br>-Special Civil Infrastructure required<br>2.Digital Sky & Celestial Bodies Space and Time Simulator Scientific Task and Proffesional Use Orientated MOS, OSS-OS and proprietary OS<br>*-Proffesional Warranty* | *-Multimedia and Immersive Industry Standards for Educational Environments*<br>-3D Universe<br>-Freedom of movement<br>-Large amount of datasets<br>-Didactical strength<br>*-Licenced SS&H Interchangeable Show content and production*<br>-Basic and Scientific All Sciences and Art Educational Tool, Space Navigation<br>-Multimedia |
| *Type 4* (type 1 + type 3)<br><br>*Hybrid (tandem)*<br><br>*Licenced SS&H* | -Sincronized (Hybrid) or tandem Digital and Optical Mapped Sky Projection<br>-Fulldome films,<br>-up to 70K Visual resolution<br>-2D/3D Slide-foto-videoplayer<br>-Digital and Optical Projected Celestial Bodies Space and Simulator<br>-Simulator and fulldome<br>-Shows Producer<br>-All Sciencies and Art, Space Navigation, Scientific and Multimedia Entertainment Activities | -Proffesional Quality and Waranty Digital for Computing, Video and Optical Hardware (State of the Art and Experimental Industry Standards).<br>-Special Civil Infrastructure required<br>2.Digital and Optical Sky & Celestial Bodies Space and Time Simulator Scientific Task and Proffesional Use Orientated<br>*-Proffesional Warranty* | *-Latest Multimedia and Immersive Industry Standards for Educational and for Realistic Visualisation and Simulated Environments*<br><br>*-Licenced SS&H*<br>*-Interchangeable Show content &production*<br>-Basic and Scientific All Sciences and Art Educational Tool<br>-Multimedia |

The consolidated data from the second table offer a sketch report of the technical performance of the Sky Simulator and of the marketing specialized in planetariums. It could be also a sketch analysis of this *niche* market and an introduction to the world of the fulldome projection, simulation and visualization of Universe. They say 'Seeing is believing', often just leaflets and websites underlie the decision to visit or even to acquire such an

equipment. How much matches what you want with what one is selling, here are aspects that drive the planetarium market and landmarks for reconsidering the dreams based to the reality of having and operating a modern planetarium. This Second Table is made consulting the official site of the worldwide renown planetarium builders: Zeiss, Evans&Suterland (ES), GOTO, RSA Cosmos (RSA), SkySkan (SS), Konica-Minolta (KM), Digitalis, Lumeau Sky System (LSS), Immersive Adventure (IA), E-planetarium (E-plt), fulldome.pro (FD), Megastar (MG). The list of the links is in the article bibliography).

Table no.2. Generic Planetarium Kits Digital Sky Simulators

| **Planeta-rium type (1,2,3,4)** | **GUI// remo-te** | **Fulldome player // as option** | **Digital Sky Simulator** | **Show Producer** | **2D/ 3D** | **Max. digital video resolution (overall figure, for each type)** | **Best Celestial Data base Offer (top 1... n)** |
|---|---|---|---|---|---|---|---|
| *Type 1 Opto-mecanic* | Yes// No | No/Spacegate/ Zeiss, Hybrid Control/Goto Geministar/KM Dome manager/ RSA | No | No | No | ZEISS, GOTO, ES, MG | Just close to best visual Northern of Southern Sky |
| *Type 2 Digital OSS&H* | Others | Others OSS type | NightShade (Stellarium for fulldome)/ Digitalis, E-plt Stelarium360/LSS, IA Horizon/FD | NightShade/ KM, others Stellarium360/ LSS, IA | Others | 2K/Digitalis, E-plt, LSS, IA, others<br><br>4k/FD | 1.E-plt 2.Horizon 3.LSS, IA 4.Digitalis |
| *Type 3*<br><br>*Digital* | Yes/ yes<br><br>all firms | Digistar/ ES Spacegate /Zeiss DigitalSky/SS Geministar/KM Dome manager/ RSA | Digistar/ES, Goto Uniview/Zeiss, others Geministar /KM SkyExplorer/ RSA, GOTO, others | Digistar/ES, Goto Uniview/Zeissoth ers SkyExplorer/ RSA, Goto, others DigitalSky/SS | Yes<br><br>all firms | 2K-8K/RSA, SS 2K-4K/ES, Zeiss | 1.RSAC 2.E&S 3.Goto 4.Zeiss 5.SS |
| *Type 4*<br><br>*Hybrid* | Yes/ yes<br><br>all firms | Digistar/ ES Spacegate /Zeiss Dome manager/ RSA | Hybrid Control Digistar/ES, Goto Uniview/Zeiss, others SkyExplorer/ RSA, Goto | Digistar/ES, Goto Uniview/Zeissoth ers SkyExplorer/ RSA, Goto | Yes<br><br>all firms | 4K-16K/RSA, Goto, ES | 1.E&S 2.RSAC/Goto 3.Zeiss 4.SS |

## 4. Conclusion or Possible Cardinal Points for a *Digital Planetarium* Compass.

A climate of cultural and social support of the interstellar adventure involves a change in guided attitude, in particular, through a process of technological and visual simulation. Humanity is already preparing for this step. (http://www.esa.int/Our_Activities/Human_Spaceflight/Mars500/Mars500_study_overview). The first cardinal point is, of course, the human factor. Even if we use a Universe/Sky digital simulator, very affordable financially and able to provide best performances in the field, the human factors remain decisive in 'long after major technological problems have been resolved'. This solution brings into question, already, two other cardinal points: the price and the performances of the *fulldome* projection. Both tables contains a synthesis of facts regarding the planetarium equipment kits than can help one educator to develop his multimedia tool adapted to discipline educational objectives and to training aims and purposes. Those tables can drive a discussion area and arena about the use of planetarium as education tool. This is a debate to be developed on condition that one can tackle one by one the needs for each domain. The scientific, artistic, aesthetic and cinematographic criteria, applied in the area of astronomy education, for all levels of School and for Life Long Learning programs will be added next to the technological and physical criteria and together, these planetarium building and operating criteria will be useful to define also the

*fulldome* documentary film. A definition of the *fulldome* documentary film will facilitate understanding this new educational and scientific equipment, namely the digital Sky Simulator.

Of course, the justification and the promotion of digital planetarium systems, in particular, is related to the production of the *fulldome* scientific documentary film, because these products are the most sought-after multimedia ones as vehicles of astronomical and astronautics information. Therefore, we could say that the fourth cardinal point of this imaginary compass would be the *fulldome* multimedia production industry using and for Digital Sky Simulators. As for choosing which one of these four cardinal points is to be the North, this is often an open question. For me, I choose the human factor as North for this imaginary compass built to find the identikit of a modern educational Sky simulator at the beginning of the Digital Age.

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